Context's modeling for participative problem solving

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Abstract

This paper reviews the interest of using context for participative simulation in virtual environment for training. Context is an interesting concept for at least two points: Virtual agents and humans have to collaborate ,so they must communicate and understand each other. This is the reason why we use a simplified analogy with human's decision-making. Our aim is to simulate some cognitive mechanisms in order to have credible agent's decision-making. We keep the notion of context. Agents reason with the situation's context, which is divided in social, environmental, historical and personal contexts. Another interesting aspect is the explanation needed when the learner makes a mistake. We argue, in this article, that context is a good concept to give better explanations. At last we show an example of an agent decision-making.

Introduction

This article introduces a context modeling for mking up a Virtual Environment for Training (VET). This VET will be used to simulate dynamic situation. For the learner, the aim is to recognize this type of situations and manage them.

Simulation in virtual reality allow the training of a learner to solve dynamic problem in a constructivist way (**?**). He will learn by doing. VET use Intelligent Tutoring System (ITS) (**?**). Those tutors implement learning strategies. Those one allow to have a pedagogical support which consists in interventions to guide the learner in his task. There is different way to help him, for example by asking about his mistake or by showing him the relevant information that he has missed.

Our work is centred on a more complex problem. We are interesting in the dynamic and collaborative situations. The learner will not follow a well defined procedure, so his mistakes are not predictable. Moreover, he has to be immersed in a virtual environment and he has to collaborate with autonomous agent to solve the problem. That is called participation. Participation is the integration of *the human in the loop* (Dautenhahn 1998; Schuler & Namioka 1993), which fully takes part in the resolution. He makes, imposes or accepts some decisions. He communicates with other actors of the resolution. This introduces a new problem: it is necessary for the various actors of the system to understand each other and to communicate.

This article deals with a contextual approach of this problem. We put forward advantages of context modeling for decison-making of autonmous agents. One can find a lot of definition of this context. We decide to keep the definition given by P. Brzillon and J-CH Pomerol (Pomerol & Brézillon 2001): *A context is a collection of significant conditions and surrounding influences that make a situation unique and comprehensible.* We have also based our work on the studies of R. M.Turner (Turner 1993) which considers that the context-sensitivity is fundamental to create an *intelligent* behaviour.

A contextual approach will allow a better explanation (Brezillon & Pomerol 1999) of mistakes done by the learner. In Virtual Reality people are represented by an avatar. This one will have a context representation of the situation. In this way, significant information when a mistake is done can easily be shown to the learner. Explanations could be too more precise about the mistake.

As we have said, we are interesting in the learner particpation in the simulation, we need to have some credible action selection for the other agents in the simulation. Like (Brzillon 1999), we think that the context integration is a way to refine this decision-making. We are using context for the agent reasoning. Like (), we argue that case-based reasoning (Aamodt & Plaza 1994) is a good solution for reasoning about context. This CBR will take in entry the context and it will return the most appropriate solution according to old solved cases of the base.

The last point, we need in a participative simulation, is the *substitution*. This concept consists in allowing the learner, during an exercice, to take control of another protagonist. The situation can be played again but the learner should be aware of the situation with the new point of view. He has to know the past experience of the agent.(R. Mendes de Araujo 2005) proposes, that the context allows to better take into account interactions between

the human and the machine. We argue that it can be a relly good way to share knowledge between human and agent. At last, we will see that it contributes to a simpler use of the concept of substitution.

This article is structured as follows, the part explains what we means by dynamic and collaborative situation, the part introduces our approach of context modeling. This part begins by a definition of context, continues with our formalism and ends with the advantages of our definition. The part deals with the actions selection. At last we show an example of the decision-making of our agent apllied to a football simulation.

Situation dynamique collaborative

D apres Tiberghien G. (2002), une situation comprend :

- des donnees interpretables en fonction des objectifs des participants.
- des agents capables de modifier la situation selon ces objectifs (inclure aussi les changements spontanes de la situation, depourvus d'objectifs).
- des agents capables d'adopter des points de vue epistemiques sur la situation en fonction de leur role (ces points de vue font aussi partie de la situation).

Le point commun de ces situations est qu'elles sont intuitivement complexes (J-M. Hoc & J-M. Cellier, 2001). Differents facteurs de complexite permettent de decrire ces situations dynamiques collaboratives.

Les facteurs de complexite issus des caracteristiques de la tache a accomplir ont une place centrale dans la litterature. Cette complexite a l'avantage d'etre objective, mesurable et reproductible. Synthetiquement, Woods (1988) propose deux types de facteurs de complexite: Les caracteristiques du systeme: la dynamique, le risque, le caractere incertain ou vague des informations, en bref les exigences de la tache. Les caracteristiques des agents: le nombre d'agents associes au fonctionnement du systeme, le caractere dynamique des roles de ces agents.

Les facteurs de complexite issus de l'expertise ou internes, c'est a dire propre aux sujets (Amalberti, 1996).Une complexite lie a la representation du systeme, des buts a atteindre et egalement des propres connaissances et savoir-faire de l'agent (de quoi suis-je capable?). Une complexite liee au partage de la representation entre agents impliques dans la meme situation, particulierement importante dans les activites collectives.

Les situations dynamiques collaboratives sont des situations evoluant de facon autonome, c'est a dire pour partie independamment des effets des actions et, au moins 2 personnes communiquent sur les actions existantes. Ces situations se caracterisent par leur complexite, les incertitudes qu'elles produisent, les risques associes, des contraintes temporelles importantes et, l'autonomie des entites integrees dans le collectif. Les interactions entre les differentes entites permettent de repondre a des objectifs communs identifies, de planifier et de gerer le temps, de partager le travail collectif et l'experience, de capitaliser des informations et de developper des competences individuelles et/ou collectives.

Ces situations se rencontrent dans de nombreux domaines lies au travail en equipe en temps contraint (urgence, securite) (Hoc 2001; **?**) ou dans les sports collectifs (G.K. 2003). La prise de decision de chacun des intervenants est faite sous pression temporelle. Il n'est donc pas possible de mettre en oeuvre des mecanismes de negociation complexes. Ceci n'exclut pas toute communication. Celle-ci est simplement breve et souvent non verbale

Les simulations en realite virtuelle permettent d'immerger un apprenant dans une situation dynamique collaborative. Dans ces environnements virtuels de formation, l'apprenant est represente par un avatar. Pour obtenir un comportement collectif, nous utilisons une approche a base d'agents simulant des prises de decision autonomes. Nous associons un agent par intervenant intgr la situation dynamique collaborative.

Nous pensons qu'une modelisation fine du contexte des situations dynamiques collaboratives permet de repondre a ces besoins. En effet, le contexte est un moyen de reifier les informations d'une situation dynamique collaborative. Nous prsentons cette modlisation dans la partie suivante.

Architecture for Training Collaborative Dynamic Situation

The comportemental architecture of agents involved in our virtual environment is shown on the figure 1. We underline that the work originality is not in this architecture. A similar one can be found in (**?**). We find interesting to introduce it in order to facilitate the comprehension of our approach of using context. Each agent has a comportemental cycle, that begins with perceptions. This perception is compared to the old one that are stored in a casebase. The most similar case is extracted and allow to define the comportement for this type of situation. The comportement consists in doing or not an action.

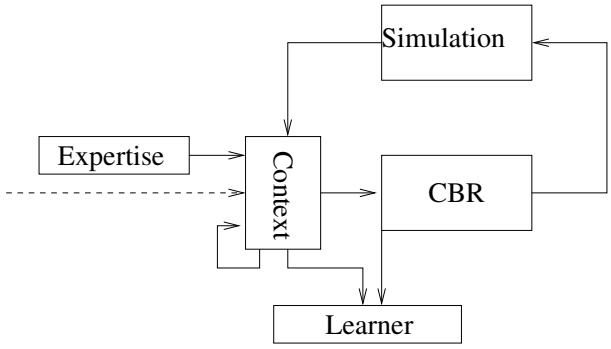

Figure 1: contexts division

In the framework of the developpement of a virtual environment for training, we have identified three axes of context using.

1. La construction de la base de cas : La definition en amont d'une telle base est tres difficile (**?**). Elle est le fruit d'une analyse fine des situations. Cette analyse repose sur des

elements pertinents (affordances ?) qui sont une abstraction de la perception, associe a une abstraction du passe du systeme. Si les regles comportementales sont difficiles a definir, les elements pertinents peuvent etre identifies par un expert du domaine. Ils constituent alors le contexte d'une situation necessaire a la prise de decision. According to (Shoham 1991), context makes it possible to simplify the representation and the comprehension of the problem by focusing the actors attention.

2. Builbing the casebase is a hard task, the crucial point is the definition of the significant information to describe a case. C'est la simulation qui revele des cas pour lesquels aucun comportement ne semble defini. L'expert est alors interroge sur ce cas, qui lui est presente apres filtrage contextuel. Cette presentation utilise les mots cles de son domaine. Elle lui est donc explicite et lui permet d'indiquer la decision a prendre.

3. Mise en place de support pedagogiques : De nombreuses strategies d'apprentissages sont definies par les pedagogues. Par exemple, il est interessant de montrer les consequences d'une erreur ou de mettre en evidence les elements de l'environnement qu'il doit considerer. Il est aussi important d'expliquer ou de poser des questions pour aider l'apprenant a comprendre le probleme. La encore, toutes ces aides pedagogiques peuvent faire l'objet d'une contextualisation. Cette fois le contexte correspond a une fusion entre le contexte du domaine, de l'historique et des notions pedagogiques plus abstraites (pourquoi, comment ? a traiter ulterieurement)

4. La subsitution : Lorsque la machine prend le controle d'un avatar, elle doit adopter le comportement le plus credible possible avec la situation courante. Si le contexte utilise pour la definition du comportement des agents est egalement calcule durant l'execution du comportement de l'avatar, cela facilitera grandement cette prise de controle. En effet, les variables contextuelles necessaires a la prise de decision, representant une abstraction de l'historique de la simulation, seront toutes renseignees au moment de la prise de contrle. De plus, dans le cas inverse, ou c'est l'apprenant qui prend le controle d'un agent, s'il recupere son contexte. Tous les mecanismes support d'explications ou d'autres interactions entre l'apprenant et l'environnement de formation seront immediatement utilisables.

Context modeling for dynamic and collaborative situation

In the framework of the collective decision-making we consider, as (R. Mendes de Araujo 2005) proposes, that the context allows to better take into account interactions between human and machine. This point seems really important to us because we want to create a participative simulation in wich human agent have to be immerged. We will introduce our approach in this section, we first detail our distinction between differents contexts, and then we present the formalism of our contexts.

Context delineation

If we can work out a contextual representation of the problem allowing to evaluate its distance to *typical schemas*, we will be able to simulate fine decision-making closer to the human one. Another aspect which justifies the use of the context is underlined in (Turner 1998). R. M.Turner argues that context allows agents to better react to unexpected events by enabling them to detect event, to evaluate it and to answer to it. This point seems important to us because our system must be open as humans or agents can enter or leave it. Moreover, if one can foresee the agents behavior in the system, one can not claim to know all the possible actions of human during the resolution.

That is the reason why we have chosen to formalize our context as (McCarthy 1993), in order to be able to compare them. Before introducing our context representation we will propose a delineation of contexts. The sum of those contexts will form the global context of the agent. We decide to follow the psychologist's point of view as it is underlined in (KOKINOV 1997) and we divide the global context in two parts. The *external* one refers to the physical and social environment, the second one refers to the internal state of the agent, such as skills, physiological, strategical...

The figure 2 illustrates the distinction between external and internal context:

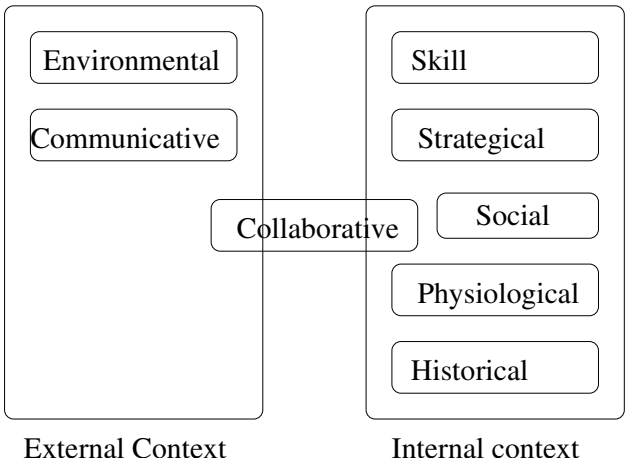

Figure 2: contexts division

The external context is made up of two more specific contexts that we will detail:

- *Environmental context* : refers to the physical elements of the simulation. This can be an actor, an object, or everything that the agent can see or hear.
- *Communicative context* : is the reunion of all the communication for the agent. We choose this name instead of social because, for us, social context means the representation of the group. But it is evident that the social context is totally dependant of the communicative one.

The internal context is the sum of five distinctives contexts that are:

- *Skill context* : represents the agent skill in the domain of the simulation. This context is usefull is the action selection when two or more actions seems to be good. The agent will choose the most appropriated one according to his skill context.
- *Physiological context* It reflects the psychological and physiological state of an agent. This agent can be disturbed, exhausted, inclined to collaboration or in peak form. It influences mainly the strategy of collaboration. It depends on the historical context
- *Social context* : It allows the agent to have an idea of the general mood of the group. This context strongly depends on the number of communications between actors, and especially on the type of conversations, such as for example number of refusals or number of requests for assistance...
- *Strategical context* : refers either the strategy that the agent should execute, or the future situation according to the agent point of view. It depends of the historical, social and environmental contexts.
- *Historical context* : It allows the agent to keep a trace of his past experience. The casebase is a way to keep information but they are not ordered. This is the role of the historical context. In practice, it is a graph containing the case used by the agent.

The last one is the collaborative context. We decide to place it in the center of the figure to show its dependance on the other contexts.

This delineation of contexts is usefull for our aim because:

- It simplifies the definition of the pertinent context to describe a situation. The expert can tell what context is important for this situation. This is important for building the casebase in the simplest way.
- This delineation allows a better explanation to the learner when he make a mistake. We can easily underline contexts that were relevant in this situation and so the learner can be concentrated on the interesting point of the explanation.
- The last point is our selection action method. The differents contexts do not have the same role in the action selection. Some of them like environmental, social and physiological are importants. As we illustrate before, the skill context will be usefull in the selection action, when two or more actions are chosen. Else it is used to specify action parameter (dexterity for an action).

Representing context

However, comprehension is not a deliberative and enumerative simple mechanism. It is often based on analogies and gatherings, what psychologists call *typical schemas* (Rosch 1975). This concept was reused by R. M.Turner (Turner 1993) as *contextual schemas* allowing the agents to reason with their representation of the context. We use schemas to represent the different contexts

These schemas have a general form and are all, at least, built up from the following attributes:

Each context can be describe with this prototype:

- *attribute:* represents either a physical object or an actor involved in the current context.
- *feature :* is a part of the attribute and represents a particular point which is interesting for this attribute.
- *action:* is the action associated to this context.

In literatur, a case in a CBR system is a problem and its solution. In our approach, a case is a context and the appropriate action. We choose to use XML to represent a case. CBML(Case-Based Markup Language) (Coyle, Hayes, & Cunningham 2002) is a good example of using XML to represent cases.

A case is divided in attributes. An attribute has been mentionned by a domain expert as relevant for this situation. For example, in the environmental context, it will be a physical object

The expert gives a weight to every attribute of a case. This weight is given in fonction of the interest of the attribute for the case.

The type of an attribute can be a value in the list:

- *fuzzy* allows to represent a concept by using words to describe a feature of the concept. An example can be closer,close,far ...
- *string* represents a string value
- *compound* an attribute can be more complex so we have to separate its features.(cf
- *exact* represents an exact value.
- *ontology* allows to calculate the similarity between two concepts stored in an ontology.

We have described our vision of the context for our agents, we will see how it is used in a case based reasoning system for actions selection.

Action selection

As we have said before we use Case-based reasoning in association with context to simulate a credible decison-making for our agents.

We will describe a CBR system and we will explain the CBR cycle. We will not explain in details our selection action like the similarity measurement, retrieving methods or learning algorithm... We just want to give an overview of the CBR that we use with context retrieval to select agent's actions. A CBR system reuses old solved problems to solve a new one. In order to be able to do that the system is made up of a base containing solved cases and the new case we want to solve.

According to (Aamodt & Plaza 1994), reasoning by reusing past cases is a powerful and frequently applied way to solve problems for humans. We can take, for example a little mathematical problem: Somebody asks you to solve 11*11 and find 121 which the good result and we ask you to find 11*12. You will not try to calculate 12*11 but adapt the result of 11*11, by doing 11*11+11, and find 132. This simple example illustrates how we can use experience to solve new problems by reusing previous one.

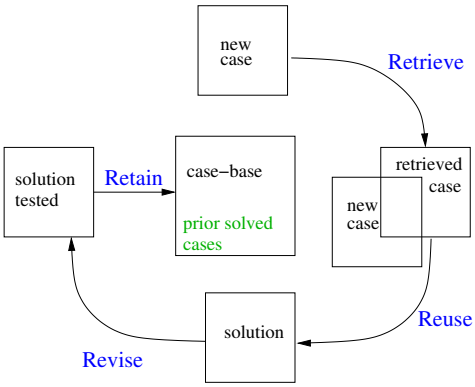

Figure 3: The CBR cycle

This example and figure 3 illustrate the principle of the CBR. The first step consists in elaborating the new case. In our approach, this step is the context retrieval. Since the agent knows the context, it will compare it to those it has in its casebase. This step is called *Retrieve*. After that, the case is adapted in order to be more appropriated, this is called *Reuse*. If the case is not contained in the casebase, the expert decides if the new case should be stored in the base.

Application example

An example to illustrate our proposition is the simulation of a football match. We are currently working with psychologists to create a virtual environment for training, called *CoPeFoot* for Collective Perception in Football. The aim is to allow users to recognize collective situation in a football match. We are not interesting in the technical aspect of football, but in the strategical one.

The example we give here is a situation where a player of the team *a* is face to a player of the team *b* and have to eliminate him. The figure illustrates the current situation.

We have chosen three contexts of the player that we will describe, those are the environmental, social and personnal. The environmental one looks like:

Conclusion

We have introduced in this article our approach for creating a virtual environment for training. After having developped what we mean by dynamic and collaborative situation, we have described the way we use context and CBR to simulate the agent comportement in this type of situations. At last, we illustrate the action selection by an example extracted of our simulation.

We argue that using context is a good way to simulate credible actions selection for autonous agents. We have the certitude that context is a good manner to enhance explanations in a non procedural training. The association with a CBR will enhance the two points we have developped just before.

We argue that the context contributes to the two previous problems: based on the ideas of Araujo (R. Mendes de Araujo 2005), according to whom a group context allows a newcomer to more quickly take into account the current situation. We believe by extension that this assertion is also true when using the context for exchanging information between a human actor and his substitute.

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